REMARKS

Preliminarily, Applicants respectfully request the Examiner to acknowledge their claim for foreign priority and receipt of the certified copy of the priority document (from the International Bureau). The certified copy of the priority document is lodged in PAIR with a date of June 10, 2008.

In reference to Fig. 2, claim 1 has been amended to recite that a first end layer 21m of the light-emitting layer 2 is in contact with the n-type clad layer 105, and that a second end layer 21n of the light-emitting layer 2 is in contact with the p-type clad layer 107. Further, claim 1 has been amended to recite that the barrier layer of the second end layer includes n-type impurities. Support is found, at page 9, lines 8-12 and at page 17, lines 28-29 of the specification.

Review and reconsideration on the merits are requested.

Claims 1 and 4 were rejected under 35 U.S.C. § 103(a) as being obvious over U.S. Patent No. 6,975,660 to Johnson in view of JP 2002-223042 to Ozaki (JP '042).

Johnson was cited as disclosing a light-emitting device comprising a light-emitting layer of multiple quantum well structure in which well layers 120 and barrier layers 125 including Group III nitride semiconductors are alternately stacked periodically between a clad layer 108 and a clad layer 112 which are formed on a crystal substrate and which include Group III nitride semiconductors, citing Fig. 12 and columns 7-9.

The Examiner acknowledged that Johnson does not teach those limitations of claim 1 which require (i) both the first and second end layers are barrier layers, (ii) the second end layer (opposed to the p-type clad layer) is thicker than the barrier layer of the first end layer (closest to and opposed to the n-type clad layer), (iii) the barrier layers other than the second end layer have a thickness of 15 nm or more and 50 nm or less, and (iv) the second end layer has a thickness of

1.2 or more times and 2.5 or less times the thickness of the barrier layers other than the second end layer.

The Examiner relied on JP '042 as disclosing a first end layer (2a) of the light-emitting layer arranged closest to and opposed to n-type clad layer 25, second end layer (2c) arranged closest to and opposed to p-type clad layer 30, where both the first and second end layers are barrier layers and the second end layer (2c) is thicker than the barrier layer of the first end layer (2a) and where the second barrier layer (2c) has a thickness greater than that of the other barrier layers (citing Fig. 4 and paragraphs [0048]-[0056]) "so that the isoelectronic level in the light-emitting layer and the quantum level in the barrier layer will fulfill the resonance conditions." The Examiner further considered the claimed thickness range of the second end layer relative to the thickness of the barrier layers other than the second end layer to be a matter of design choice and subject to optimization.

The reason for rejection was that it would have been obvious to substitute the active region of the device of JP '042 for the active region 110 of the device of Johnson.

The rejection should be withdrawn because JP '042 neither discloses nor suggests the features of claim 1 "wherein the barrier layers other than the second end layer have a thickness of 15 nm or more and 50 nm or less, and the second end layer has a thickness of 1.2 or more times and 2.5 or less times the thickness of the barrier layers other than the second end layer." The reason therefor is described below.

i) To begin with, a first p-type nitride semiconductor layer 28 is inserted between a barrier layer 2c and a p-type clad layer 29 in JP '042 (Figs. 4, 6-8 and paragraph [0080]). Such a layer 28 is absent in the present invention. Further, the structure of a laser device disclosed in

JP '042 is different from that of the present invention in that a light guiding layer 26 is inserted between a barrier layer 2a and an n-type clad layer 25 in JP '042.

Accordingly, "a second end layer of the light-emitting layer is closest to and opposed to the p-type clad layer" recited in claim 1 of the present application is amended to "a second end layer of the light-emitting layer is in contact with the p-type clad layer" so as to exclude the first p-type nitride semiconductor layer 28 of JP '042. In addition, "a first end layer of the light-emitting layer is closest to and opposed to the n-type clad layer" recited in claim 1 of the present application is amended to "a first end layer of the light-emitting layer is in contact with the n-type clad layer".

ii) Moreover, the first p-type nitride semiconductor layer 28 of JP '042 is an electron confinement layer and has a function of confining the electrons and preventing carriers from overflowing (paragraph [0064]). However, since the layer 28 of JP '042 is formed of a nitride semiconductor whose bulk resistance is large (paragraphs [0064] and [0065]), an increase in forward voltage Vf cannot be avoided (paragraph [0065]).

As explained above, since the electron confinement layer causes an unfavorable result that forward voltage Vf increases, the electron confinement layer is not formed between an active layer and a clad layer in the light-emitting device according to the present invention. According to the present invention, it is possible to effectively confine electrons in the well layer without separately providing an electron confinement layer as described above by making the thickness of the second end layer 1.2 times or more and 2.5 times or less the thickness of the other barrier layer (page 8, lines 12-23). Accordingly, the appropriate thickness of the second end layer is understood to be different between the device in JP '042 which provides the electron

confinement layer 28 and that of the present invention which does not provide an electron confinement layer.

iii) "First barrier layer" of JP '042 is a barrier layer arranged in a position closest to the p-type nitride semiconductor layer, which is, for example, a layer 2d in Fig. 3 or a layer 2c in Figs. 6 to 8, and appears to correspond to the barrier layer of the second end layer of the present invention.

However, JP '042 describes, in paragraph [0052], that the reason why the first barrier layer is made thicker is that it becomes possible to perform a stable carrier injection and recombination even under a high output condition since a larger space is made available as the first barrier layer which includes a large amount of p-type carriers.

This means that the purpose of making the first barrier layer thicker in JP '042 is to stably inject p-type carriers (i.e., holes) into the active layer, but not to effectively confine n-type carriers (i.e., electrons) in the well layer.

As described above, the first barrier layer of JP '042 is different in nature from the barrier layer of the second end layer of the present invention. Consequently, JP '042 neither discloses nor suggests the invention of present claim 1 in which the thickness of the second end layer is 1.2 times to 2.5 times the thickness of the other barrier layer.

iv) Furthermore, JP '042 describes, in paragraph [0051], that it is an important factor in enhancing the efficiency of injecting the p-type carriers (holes) for the first barrier layer not to substantially include n-type impurities as well as for the first barrier layer to include p-type impurities. This means that JP '042 discloses that, if the first barrier layer includes the n-type impurities, desired effects cannot be obtained.

In view of the foregoing, claim 1 of the present application is further amended with the limitation that "the barrier layer of the second end layer includes n-type impurities", so that the difference is clarified between the barrier layer of the second end layer of the present invention and the first barrier layer of JP '042.

Withdrawal of the foregoing rejection under 35 U.S.C. § 103(a) is respectfully requested.

Claim 2 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Johnson in view of JP '042, further in view of JP 7-86637 to Itaya. Claim 3 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Johnson in view of JP '042, further in view of JP 2001-102629 to Marui.

Claims 2 and 3 are patentable for the same reasons that claim 1 is patentable over the cited prior art. Applicants further comment as follows.

As to the rejection of claim 2 under 35 U.S.C. § 103(a):

(1) The invention in U.S. Patent No. 6,975,660 (Johnson) relates to a vertical cavity surface emitting laser (VCSEL) that emits a laser beam having a long wavelength (Abstract).

i) The thickness of the various layers constituting the VCSEL is defined to form a Fabrey Perot resonator, and the quantum wells should be positioned so that they are roughly centered at an antinode of the electric field (col. 1, line 64 to col. 2, line 2). For example, if the VCSEL is formed while the quantum wells thereof are grown past their critical thickness, they relax by creating dislocations, and thus resulting in a poor quality active region (col. 1, lines 62-64). In addition, the barrier layer thicknesses need to be determined such that positions of the quantum wells that are formed between the barrier layers are not excessively far from the antinode of the electric field (col. 2, lines 4-7).

ii) The VCSEL disclosed in Johnson is also subjected to structural restrictions similar to those applied to the aforementioned conventional VCSEL (col. 8, line 63 to col. 9, line 5).

iii) Further, in the case of the VCSEL disclosed in Johnson, it is described that the preferred embodiment uses a layer thickness of quantum wells of less than 50 angstroms, i.e., less than 5 nm (col. 9, lines 21-22, claims 6, 8 and 10, etc.).

(2) In contrast, the semiconductor device disclosed in JP '042 is not subject to the structural restrictions similar to those applied to the VCSEL. Therefore, if the VCSEL disclosed in Johnson is formed by using the barrier layer of the semiconductor device of JP '042, it is possible that the VCSEL does not exhibit its original, intended function.

In addition, it is described that, in view of increasing the life of the device, it is preferable that the semiconductor device disclosed in JP '042 have a well layer thickness ranging from 50 angstroms (5 nm) to 200 angstroms (20 nm) (paragraph [0011] of JP '042). Accordingly, if the VCSEL disclosed in Johnson is formed by using the well layer of the semiconductor device of JP '042, the well layer of the VCSEL is formed beyond its critical thickness or formed in a position excessively far from the antinode of the electric field, which may cause the VCSEL not to exhibit its original, intended function.

Further, if the VCSEL disclosed in Johnson is formed by using a barrier layer disclosed in paragraphs [0027] to [0029] of Itaya et al.(JP 7086637), i.e., each of the barrier layers which has a thickness increased gradually from the first end layer toward the second layer, the well layer of the VCSEL is formed beyond its critical thickness or formed in a position excessively far from the antinode of the electric field, which may cause the VCSEL not to exhibit its original performance.

3. As to the rejection of claim 3 under 35 U.S.C. § 103(a):

Murai (JP2001-102629) discloses a three-tier structured barrier layer composed of a bottom layer 7a-(1) formed of undoped GaN, a middle layer 7a-(2) formed of Si-doped GaN, and a top layer 7a-(3) formed of undoped GaN (paragraph [0033]).

However, among seven barrier layers, the barrier layers from the bottom layer to the 6th layer from the bottom are the three-tier structured barrier layers, while the barrier layer 7a' of the top layer is undoped (paragraphs [0033] and [0034]).

For this reason, Murai neither discloses nor suggests the invention recited in claim 3 of the present application.

Withdrawal of the foregoing rejections under 35 U.S.C. § 103(a) is respectfully requested.

Withdrawal of all rejections and allowance of claims 1-4 is earnestly solicited.

In the event that the Examiner believes that it may be helpful to advance the prosecution of this application, the Examiner is invited to contact the undersigned at the local Washington, D.C. telephone number indicated below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

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